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Titre :

Title :

Amendment 1 to IEC 60936-1 Maritime navigation and radiocommunication equipment and systems - Radar - Part 1: Shipborne Radar - Performance requirements - Methods of testing and required test results

Note d'introduction

Introductory note

This amendment adds a new annex D - Unwanted emissions of radar systems - Methods of measurement and required results. This is to allow the measurement of unwanted emissions from radar equipment in order to comply with the new requirements of ITU-R

ATTENTION**CDV soumis en parallèle au vote (CEI)
et à l'enquête (CENELEC)****ATTENTION****Parallel IEC CDV/CENELEC Enquiry**

Annex A

Annex B

Annex C

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Annex D (normative)

Unwanted emissions of radar systems **Methods of measurement and required results**

D.1 Introduction

ITU-R has now developed a new recommendation for out-of-band (OOB) emission limits (D.6.d)) This recommendation is associated with the following recommendations:

- a) OOB emissions falling into an adjacent allocated band (OAB)(D.6.f))
- b) Boundary between OOB and spurious emissions (D.6.e))
- c) Spurious emissions – SM.329 (D.6.c))

Spurious emission limits have been incorporated into the Radio Regulations, in terms of level, but not in terms of frequency range. There is no intention at present of a similar treatment for either the OOB or OAB limits.

It has been agreed that within the ITU WRC – 2003 Agenda item 1.8.1 the boundary between OOB and spurious emissions will be defined for all radio services and incorporated into Appendix S3 of the Radio Regulations. As this will not occur until after the date of 1 January 2003 (the date at which the new spurious limits apply for new radar installations), there is a need for this standard to define the boundary conditions based upon the text contained in the recommendation ITU-R SM [Boundary] (D.6.e)).

The purpose of this Annex is to define how the requirements of Appendix S3 of the Radio Regulations and these new ITU Recommendations concerned with unwanted emissions are to be implemented with regard to marine radars. This includes the requirements, method of measurement, the results to be obtained and the interpretation of the measurement results.

D.2 Requirements

The requirements are defined in Appendix S3 of the Radio Regulations and the recommendations listed above in D.1.

The boundary between the OOB and spurious domains and the OOB mask are defined in the OOB recommendation – Annex 8 in the following manner –

- a) (Boundary and mask) – “the mask rolls off at 20dB per decade from the 40 dB bandwidth to the spurious level specified in Appendix S3 of the Radio Regulations. The B_{-40} dB bandwidth can be offset from the frequency of maximum emission level, but the necessary bandwidth (S1.152 of the Radio Regulations) should be contained completely within the allocated band”.
- b) (Exclusions) – “the OOB limits are not applicable inside exclusive Radiodetermination and or Earth Exploration Satellite (EES) and Space research service bands.”

These requirements are illustrated in Figures D.1 and D.2.

The OOB masks shown in Figures D.1 and D.2 are calculated using the transmitted pulse width and rise time.

The necessary bandwidth and the – 40 dB bandwidth are generally centred about the operating frequency but may be offset to take account of spectrum asymmetry.

The OOB mask commences at a level of – 40 dB and falls off at the rate of –20 dB per decade until it meets the spurious emission limit at the OOB boundary.

When the calculated – 40 dB bandwidth falls within the allocated band the OOB mask commences at the edge of the allocated band.

When the – 40 dB bandwidth falls outside the allocated band the OOB mask commences at that point in the adjacent band.

The OOB mask can be offset further into the adjacent band to allow for spectrum asymmetries, but the necessary bandwidth associated with this mask shall be contained completely within the allocated band.

The OOB mask emission limits only apply outside the adjacent bands i.e. below 2.7 GHz and above 3.3 GHz in the case of radars operating in the 2.9 GHz to 3.1 GHz band, and below 8.5 GHz and above 9.8 GHz in the case of radars operating in the 9.3 GHz to 9.5 GHz band.

Emissions in the spurious domain (Figures D.1 and D.2) shall be at least $43 + 10 \log \text{ PEP}$ or 60 dB, whichever is the least stringent, below the carrier power, as measured in the far field of the radar. For most current marine radars the limit will be 60 dB and this means that the spurious domain starts at $5 \times B_{-40}$ from the operating frequency of the radar.

D.3 Methods of measurement

The basic methods of measurement for unwanted emissions are contained in ITU-R Recommendation M.1177 (D.6.a)). This describes two methods, referred to as the “direct” and “indirect” methods. Either method is admissible.

Measurements are to be made for all frequencies in the measurement frequency bands specified in the table D.1 below.

Table D.1 – Measurement frequency ranges

Allocated band	Measurement band (GHz)	
	Lower limit	Upper limit
2.9 GHz – 3.1 GHz	2 GHz	5 th harmonic
9.3 GHz – 9.5 GHz	0.7 of the waveguide cut-off	26 GHz

D.4 Guidelines for the use and interpretation of Recommendation RM.1177

The recommendation provides some specific techniques for the measurement of the unwanted emissions of radar systems, that in principle can be used for any type of radar system. In practice, the recommendation makes no attempt to provide detailed test methods for each type of system.

This standard provides the additional detail required for the minimum test requirements for the measurement of marine radars as a basis for certification, that the particular marine radar system under test, meets the requirements of the Radio Regulations and ITU-R Recommendations as appropriate.

D.4.1 Selection of pulse widths

The ITU-R Recommendation on OOB (D.5.d)) applies to complex and simple radars with user-selectable pulse waveforms. The B_{-40} bandwidth shall be calculated for the shortest pulse width used in order to create the OOB mask, which then applies to all pulse widths provided. Emission measurements only need to be carried out for this case.

The manufacturer shall declare the shortest pulse width and the corresponding pulse rise time.

D.4.2 Measurement in azimuth and elevation - antennae

For marine radars that are essentially surface search radars, there is no requirement to make measurements in the vertical plane.

For measurements in the azimuth plane, the antenna may be either rotating or the measurement system may be aligned to the antenna bore sight and measurements in azimuth taken at appropriate antenna angles where the directions of unwanted emissions are known. Both techniques are admissible and the particular choice shall be made by agreement between the manufacturer and the test authority.

In both cases the maximum value of the emission occurring in the azimuth plane shall be recorded over the frequency range defined in table D.1.

Provided that all of the antennae to be used with the equipment under test are of the same type, then only the smallest (i.e. that with the largest azimuth beamwidth) need to be used to verify compliance with the unwanted emission requirements.

D.5 Results required

D.5.1 Necessary bandwidth

The necessary bandwidth as calculated from the measured pulse width and rise time shall be within the allocated frequency band.

D.5.2 B₄₀ bandwidth

The B₄₀ bandwidth shall be calculated using the methods in Annex 8 of reference D.6.d). This bandwidth together with the declared frequency of the pulse transmission are used to determine which of the masks illustrated in Figure D.1 or Figure D.2 shall be used for the purposes of conformity.

D.5.3 Emission spectrum

The emission spectrum shall be below the calculated mask, as determined by D.5.2 above, in both the OOB and spurious domains, for all appropriate frequencies over the ranges specified in table D.1. As previously indicated in D.2, the OOB emission masks limits do not apply within the allocated band or the adjacent RD/ESS bands.

The spurious emission limit applies in the spurious domain, regardless of frequency band.

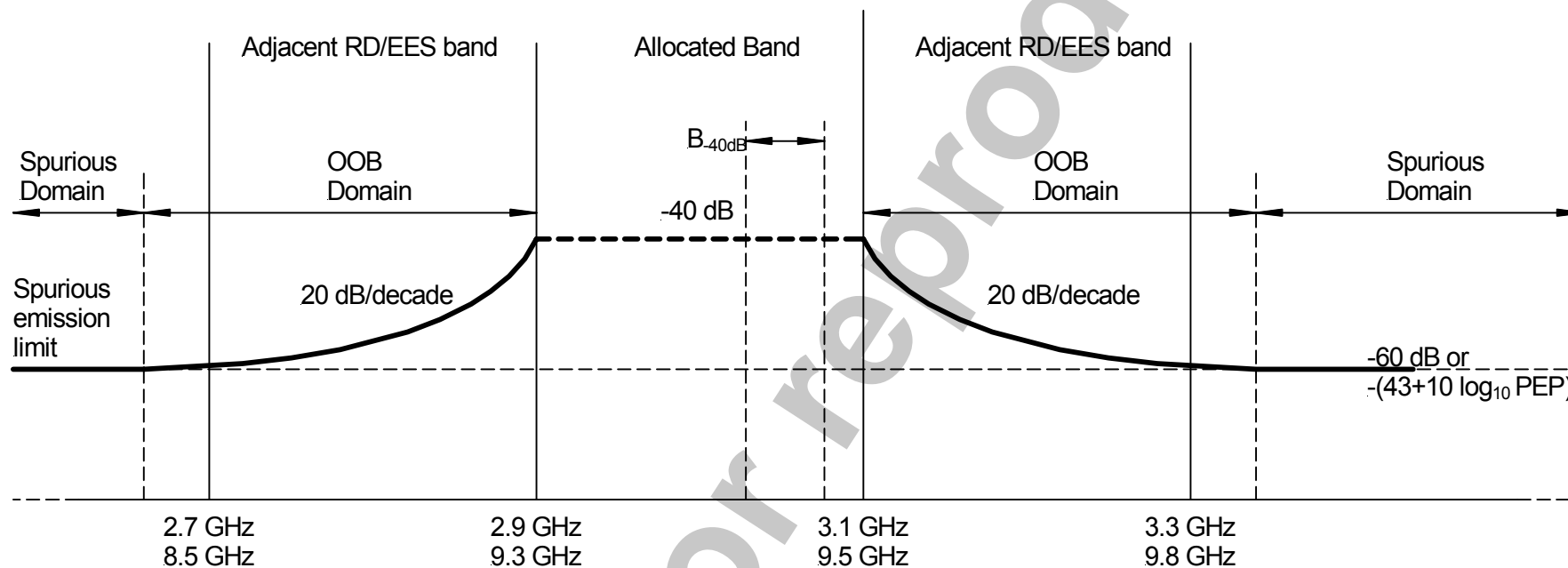
Systems shall be compliant if the OOB mask of Figure D.2 is offset further into the adjacent band to allow for spectrum asymmetries, provided that the necessary bandwidth associated with this mask is completely contained within the allocated band.

D.6 References

- a) ITU Recommendation RM.1177 – Techniques of measurement of unwanted emissions for radar systems
- b) ITU Recommendation RM.1313 – Technical characteristics of maritime radionavigation radars
- c) ITU Recommendation SM.329 – Spurious emissions
- d) ITU Recommendation SM. [OOB] – Out-of-band emissions

- e) ITU Recommendation SM. [Boundary] – Variation of the boundary between the out-of-band and spurious domains required for the application of Recommendations ITU-R SM.329 - Spurious emissions and ITU-R SM. [OOB]
- f) ITU Recommendation SM. [OAB] – Unwanted emissions in the out-of-band domain falling into adjacent allocated bands.
- g) ITU – Radio Regulations – Appendix S3 – Spurious emissions

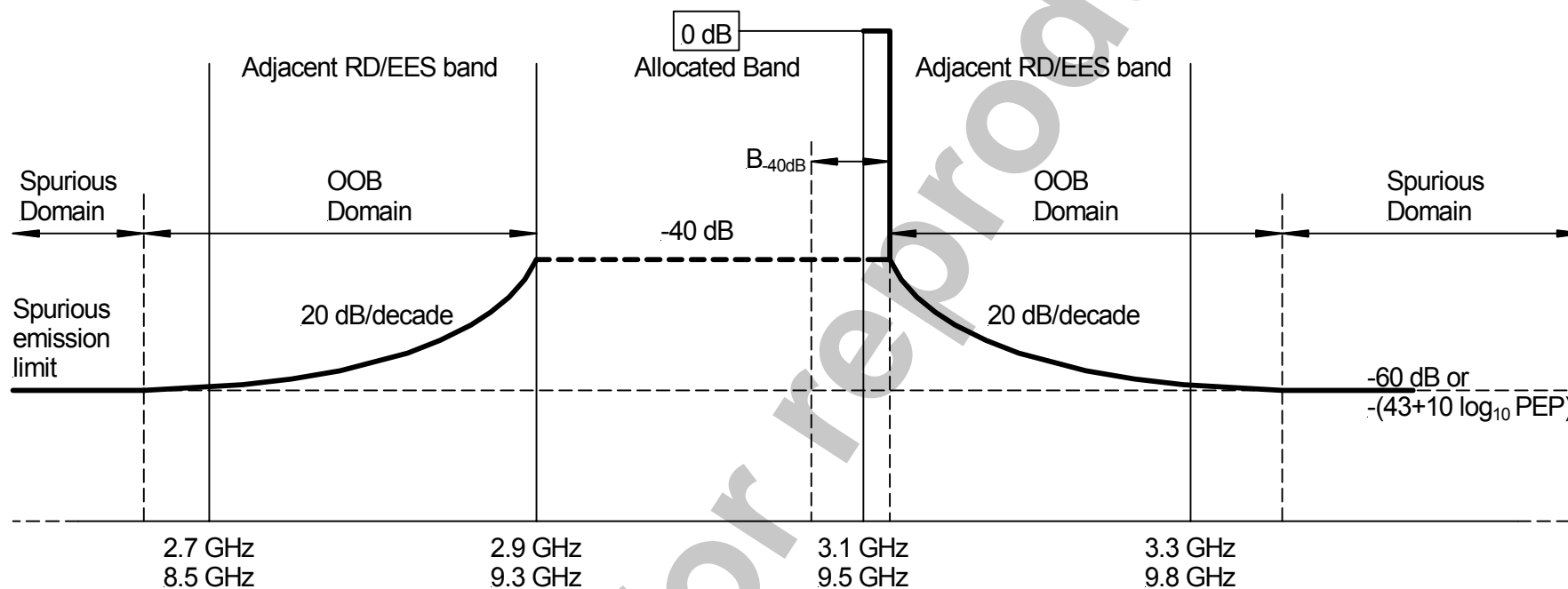
NOTE – the latest version of the ITU-R Recommendation shall be used.



NOTE: - RD / EES - Radiodetermination / Earth Exploration Satellite

NOTE: - OOB emission mask limits do not apply within the allocated or adjacent RD/EES bands

Figure D1. B₋₄₀ falls within the allocated band



NOTE: - RD / EES - Radiodetermination / Earth Exploration Satellite

NOTE: - OOB emission mask limits do not apply within the allocated or adjacent RD/EES bands

Figure D2. B₋₄₀ falls outside the allocated band